Estimation of Moisture Content of Forest Canopy and Floor From SAR Data
Part II: Trunk-Ground Double-Bounce Case

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Several scattering mechanisms contribute to the total radar backscatter cross section measured by the synthetic aperture radar (SAR). These are volume scattering, trunk-ground double-bounce scattering, branch-ground double-bounce scattering, and surface scattering. All of these mechanisms result in measurements which are directly related to the dielectric constant of forest components responsible for that mechanism, and hence to their moisture content. Hence, in principal, it is possible to retrieve the moisture content from SAR data. Since including all of the above mechanisms in the estimation problem is not possible due to the large number of unknown parameters they introduce, each of them needs to be considered individually. in a previous paper, we have discussed the case where the radar backscatter is almost entirely due to volume scattering. In the present work, we will consider the trunk-ground double-bounce mechanism. For the volume scattering case, we identified the real and imaginary parts of the dielectric constant of the branch layer components as the unknowns to be estimated. For the trunk-ground double-bounce case, we will identify the complex dielectric constant of trunks and the complex dielectric constant of ground as the unknowns. Forest floor roughness as well as trunk height, diameter, and density will be assumed known. We will also use empirical relationships between the real and imaginary parts of the trunk dielectric constant to reduce the number of unknowns. The estimation algorithm is then carried out as follows: parametric relations between the radar backscatter (trunk-ground scattering only) and the unknowns are derived by fitting higher-order polynomials to the numerical results generated from a discrete-component forest scattering model. The unknowns are then inverted, or estimated, through a nonlinear optimization technique applied to SAR data using the parametric. models. This algorithm is first test using synthetic data. It is then applied to AIRSAR data from an old jack pine stand in the BOREAS southern study area, for which a classification algorithm indicated the double-bounce mechanism to be the prominent scattering mechanism. This stand is characterized by very tall trees, a sparse branch layer, and a "smooth" surface. Extensive ground-truth data exist for this area. The estimation results are compared to the dielectric constant and moisture content measurements for this stand, where it is seen that good agreement exists between the two.

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